SECTION THREE – FACT SHEETS

Chapter Seventeen – Intertidal Zone

Life Between the Tides
Suggestion for a Low Impact Visit to the Shore
Intertidal Plants and Animals

Fact Sheet – Life Between the Tides

The complex habitat between low and high tide supports a diversity of plants and animals that must adjust to a wide range of living conditions. No other place on earth experiences such drastic physical changes daily like this narrow strip caught between the ocean and land. Whether a tidepool or a mudflat, the plants and animals here are well adapted for harsh conditions.

TIDEPOOLS

Natural basins and crevices which retain pools of seawater as the tide recedes are called tidepools. These crevices in the rocky surfaces provide places for an abundance of animals to hide and protect themselves. Some will spend their entire lives in a tidepool, while some are temporary visitors—coming and going with the tides. Others stay only part of their life cycle.

By definition, to be a tidepool, there must be a tidal change. The tide along Acadia's coast ranges from eight to 14 feet. Yet, places like Sand Beach and Otter Cliffs are not known for their tidepools. Why not? There is no place for the tide to leave pools on a flat beach or a sheer cliff. In other places along Acadia's coast, rocks descend more gradually to the sea, leaving places for water to pool as the tide drops. These tidepools are found in the intertidal zone, the area covered with water at high tide but exposed at low tide.

Even within the intertidal zone, tidepools vary. This special area further divides into smaller bands or zones which support various forms of plant and animal life. The pools higher on the shore will undergo the greatest changes in temperature, salinity, and water level. Some plants and animals that thrive in one zone may not survive as well in another. The best time to visit the intertidal zone is during low tide, when more of the area is exposed. *Please be sure to read tips for a low impact visit on page 3-76.*

Splash Zone

The highest zone along the coast is the splash zone or the black zone. The names offer clues about the place. Found above the usual high tide line where the waves may splash the exposed rock, it appears black. Its color comes from an organism called a blue-green algae (which is actually black and a cyanobacteria!). This zone is very slippery when wet. Not much else lives in this zone besides rough periwinkles. These creatures are so small that you might not notice them at first. But once you begin to see them in the cracks and crevices, their numbers might surprise you.

The Barnacle Zone

Continuing toward the water, you will next enter the barnacle zone. Here the whitish conical shells of these marine creatures cover the rocks. Many boat or dock owners consider barnacles a nuisance to be scraped off.

However, closer study reveals that these are fascinating animals. Barnacles begin their lives in a significantly different form. They are tiny members of the zooplankton (animal plankton) which is washed about by waves and tide. Eventually, they must find a spot to settle for the rest of their lives. Living near other barnacles seems particularly beneficial.

From our human point of view, living in the intertidal zone might seem rather inconvenient. But for the barnacles, this location provides some advantages. During high tide, they can open their shells to feed or reproduce. During low tide, the exposed creatures must close their shells to avoid drying out. While the water removes food and needed moisture, it also removes many marine predators. This zone also supports both dog whelks, which feed on barnacles, and common periwinkles, which feed on algae.

Rockweed Zone

While animals characterize the barnacle zone, the rockweed zone is characterized by plants. The most obvious group, the rockweeds, includes knotted wrack and bladder wrack. These seaweeds attach to the rocks and drape over them at low tide. As the tide rises, little bumps or air bladders help the plant float toward the surface of the water. This allows more sunlight to reach the plant for photosynthesis. Moving the rockweed aside, you can expose the animals staying hidden and moist under it. (Be sure to replace the plants when you finish looking. The animals need their protection.) Two introduced species, green crabs and common periwinkles, thrive here. Dog whelks, smooth periwinkles, and limpets move over the rocks. (Don't try to pick up the limpets. They need to stay in their chosen places). Likewise, blue mussels should remain where they have anchored themselves to a rock. Their byssal threads are very strong and are being researched for possible insights into dental adhesives.

Irish Moss Zone

The Irish Moss Zone commonly merges with the zones above and below it. The characteristic plant in this area grows in small but thick patches and has amazing iridescent tips. If the plant is removed from the water, it loses this coloration. Irish moss is harvested and used as a thickener in ice creams, chocolate milk, and other products. (look for carrageenan in ingredients). Dulse and sea lettuce also grow here.

Dulse is another red algae. It is sometimes dried and sold in strips as a chewy snack, or shredded and used as a seasoning. Sea anemones and nudibranchs, or sea slugs, might be found tucked into the rocky crevices. Anemones attach themselves to the rocks and use their sticky tentacles to sting small prey that swims or drifts by. Nudibranchs can eat anemones. Some of them can transfer the anemones stinging cells to projections on their own backs to serve as protection from predators.

Kelp Zone

The next and final zone is the kelp zone. Here, as you might imagine, the kelps grow. These brown seaweeds almost always remain under water. They have three main body parts: the holdfast attaches the plant to the rock, the stipe resembles a stem, and the blade looks like a leaf. Within the kelps, there is wonderful variation. Imagine what the horsetail kelp and sea colander look like. Many of the tidepoolers' favorite creatures such as the sea star, sea urchin, and sea cucumber reside in this zone. All these animals are echinoderms, meaning they have spiny skin and radial symmetry (usually with five sections). Rock or Jonah crabs live here where lobsters might rarely be found. As you can see, within the tidepools, an amazing amount of life exists in very concentrated areas. The zone divisions allow different organisms to find their appropriate niche. For example, competition between plants is minimized because the different color algae photosynthesize with different wavelengths of light. Green algae grow in upper zones while red and brown algae grow in progressively lower zones and use the light that reaches their depths.

MARSHES, MUDFLATS, AND OTHER MUCK

Rocky shores are the most obvious coastal feature, but in quiet coves one can find mudflats. Mud collects in estuaries, marshes, mudflats, and other places with still or slow moving water such as Ship Harbor mudflat. Rivers and streams wash down the particles of mud. Waves and currents then move them about. But as the water loses energy, it drops its larger loads until, eventually, even the mud settles out. The mud that settles in the intertidal zone is covered at high tide and exposed at low tide. Gulls, herons, and other birds can be found at low tide feeding in the mud, extracting clams and marine worms.

Mud is a suitable habitat for these invertebrates offering them protection. They are less likely to be found by various predators, and less likely to be dried by the sun or wind when the tide recedes. Furthermore, the mudflat's environment, not suitable for other species, limits competition faced by its inhabitants.

But living in the mud does have some disadvantages. For one thing, there is not much oxygen in mud. This condition suits the anaerobic bacteria that live there. As

the name implies, this bacteria does not need oxygen. But other mud dwelling animals need more than is readily available. What to do? Anyone who has been clam digging knows that some creatures in the mud have their own siphons or tunnels to the surface. Through this opening, the critters below can access oxygen and water. The water can bring food and wash away waste.

TIDES

Both tidepools and mudflats are greatly influenced by the action of the tides. Around Acadia National Park, the tide has a general fluctuation of eight to 12 feet twice daily (reaching 14 feet at certain times). A 12 foot change might not seem particularly significant in the middle of the Gulf, but along the shoreline it's quite important. Imagine your home filling with 12 feet of water twice a day, or a 12 foot deep pond draining twice a day. The plants and animals that live along the Gulf's edge face such dramatic changes. But what causes these tides?

The answer is complicated and includes many factors such as the shape of the water basin and the direction of the Earth's rotation. A simplified answer focuses on the gravitational forces between the Earth, Moon, and Sun. Any two bodies in space will exert a gravitational pull on each other. The Earth and Moon are two such bodies. The Moon is much smaller than the Earth but still influences it. Over 70 percent of the Earth's surface is covered with water which is pulled toward the Moon. Even the ground responds to this gravitational pull, but is less noticeable.

At the same time, there is a corresponding bulge on the backside of the Earth. Explanations for this bulge vary and involve the Earth's rotation, centripetal/centrifugal force and the result of land under water being pulled toward the Moon. In a simplified model, any place on the earth's surface will pass through both of these bulges during each 24 hour revolution. Each bulge results in a high tide. So, we have two high tides each day: one when we are close to the Moon, the other when we are far from it. The spaces between the bulges have had the water pulled from them, resulting in two low tides each day.

These high and low tides do not occur at a set hour every day. Instead, each one happens about 50 minutes later than it did the day before. Why? The earth completes a rotation each day while the moon's revolution around the earth requires approximately 28 days. Imagine standing at Ship Harbor with the moon directly overhead. If you stayed for 24 hours, you'd experience one complete rotation of the Earth. When you and Ship Harbor returned to your "starting point," the moon would no longer appear overhead. Instead it would have moved about 1/28th of the way around the Earth. Therefore, the Earth must continue revolving for approximately 50 minutes to "catch up" with the Moon.

The Sun also influences the tides. Being so far away, it plays less of a role than the moon. But, because of its large size, it still has quite a pull. When the Earth, Moon, and Sun are all in line (at each full moon and new moon) the high tides are extra high and the low tides are extra low. These extreme tides are called spring tides. (They have nothing to do with the season of spring, but come from the Old English word meaning to spring up). When the Sun and Moon are at right angles to each other (at the first and third quarter moons) their pull on the tides works against each other. At such times, the tidal change is the least significant. These small tides are called neap tides (and come from the same word as nap).

The diverse sea life in the intertidal zone is a valuable resource. The National Park Service at Acadia National Park is charged with the protection of this fragile area. We invite investigation but ask that all organisms remain undisturbed. Please leave behind any plant or animal (living or dead), sand, rocks, or any other natural material. Enjoy and explore a unique region, but take part in the protections and preservation of this habitat.

Fact Sheet
Suggestions for a Low Impact Visit to the Shore

Always consult a tide chart before planning your trip! Also take into consideration that on the day of your trip, if seas are rough, tidepools may not be as exposed and extra caution for safety is advised.

Park staff encourages visitors simply to explore and watch intertidal animals rather than disturb them from their natural environment. You can learn a lot by watching them in their habitat! However, if you choose to allow your group close up inspection of some of these critters, please follow these guidelines:

- Never force an organism from its home if it is reluctant to "let go." Sea urchins' and sea stars' delicate tube feet are easily torn. Slow, gentle nudging may release an animal's grip. Limpet shells are easily broken and should be left in tidepools undisturbed.

- Never remove excessive quantities of seaweed.

- Keep cold water in the containers at all times.

- Limit the number of common organisms examined. If possible, select only one organism of each species for examination.

- Return organisms to the exact locations they were found.

- If examining a mudflat, please ask your group to be considerate about digging. If any digging takes place, it should be done as a demonstration, rather than have each individual in an entire group scrounging beneath the surface to see what they can find.

Tips for Exploration

- Look underneath seaweeds; they provide great moist environments where creatures (especially crabs) may hide while the tide is out!

- Animals may hide if water is disturbed. Observe tidepools carefully before reaching in to explore.

- Allow sufficient time for independent exploration. Discovery brings out magic.

- Have fun and be safe. Remember, seaweed is slippery!

Fact Sheet – Common Intertidal Animals

BLUE MUSSEL

Mytilus edulis—A common tidal creature, the blue mussel's two identical shells joined by a hinge identify it as a bivalve. They grow to about 4 inches. Tough byssal threads help secure the blue mussel to rocky surfaces. Food is ingested after slightly opening the shell to allow water to move through its body cavity. The blue mussel then extracts microscopic plants and animals, trapping them on sheets of mucus.

COMMON PERIWINKLE

Littorina littorea—This small snail is well known to tidepool explorers. Scattered everywhere in the upper and mid tidal area, the periwinkle is identified by its somewhat flattened conical shell in shades of olive to gray. The elliptical opening of the periwinkle is protected by a hard plate (operculum) that closes to protect the snail from drying out or from predators. Periwinkles inch along tidepools with a muscular foot, and feed by scraping algae off of rocks using its radula, a tongue-like appendage with rough pointed teeth.

DOG WHELK

Thais lapillus—Found in the mid tidal area, the dog whelk is distinguished from the periwinkle by its pointed spiral shell, colors of yellow, orange, cream or brown appearing in bands, and the obvious groove in the dog whelk's shell opening. This groove is used for the dog whelk's radula, adapted to drill through mollusk shells to eat the animal inside. Small, rice-like grains in clusters attached to the sides of tidepools are the dog whelk's eggs.

GREEN CRAB

Carcinus meanus—This relatively small crab, only 3 inches in size, is found in upper tidepools, mudflats, and salt marshes. Despite the small size, they can give quite a pinch. It is a scavenger that feeds on decaying plants and animals. Look for it under rockweeds —watch it walk sideways to get away!

SEA STAR

Asterias vulgaris—Although immediately identified by its five arms, there are many variations in this popular tidepool creature. They can grow up to 8 inches and come in hues of orange, red, purple, brown, and yellow. Hundreds of tube feet, operated by the sea star's "hydraulic system," move the animal along in the lower tidepools. Sea stars are predators, and eat animals like mussels by encircling the shell with its arms and then pulling the shell open. The sea star places its stomach inside the shell and then ingests the animal.

SEA URCHIN

Strongylocentrotus droebachiensis—Appearing as green pin cushions, sea urchins are found in the lower tidepools. A relative of the sea star, the sea urchin also has five arms, easily seen by looking at one of the empty shells commonly found broken on the rocks. (Sea urchins are a favorite food of sea gulls!) Sea urchins move with tube feet and feed by using five triangular teeth to scrape algae from rocks.

SEA CUCUMBER

Cucumaria frondusa—An odd creature, this leathery animal can look like a small fat football or a long rubbery cucumber. Five rows of tube feet connect this animal to the same family as the sea star and sea urchin. Tentacles that are often hidden from view protrude to feed on microscopic plants from the ocean waters. When seriously disturbed or threatened the sea cucumber may try to escape by throwing up its internal organs. The amazing thing? They will regenerate their organs, just as a sea star can re-grow its arms.

HERMIT CRAB

Pagurus sp.—The small hermit crab looks for its own home by choosing empty periwinkle and dog whelk shells to fit its soft abdomen, providing it with protection. Its five pairs of claws are well adapted for its life in a borrowed home—the front two are for grabbing, the two middle pairs are for walking, and the last two pairs help the snail stay snug inside the shell.

LIMPET

Acmaea testudinalis—Appearing as a small conical hat on tidepool rocks, this little snail forms a strong attachment to the rocky bottoms and sides of tidepools with its muscular foot. It clamps down tight to withstand both crashing waves and periods of exposure. Trying to remove a limpet from a tidepool could seriously injure the animal.

ROCK BARNACLE

Balanus balanoides—Common in the upper intertidal areas, barnacles blanket the rocks creating a whitish stripe that help distinguish one of the intertidal zones. Barnacles have a six-sided conical shell which protects the small crustacean—a relative of crabs, lobsters, and shrimp. When the tide comes in, barnacles feed by opening the hinged plates on top of its shell extending its six pairs of feathery feet to filter microscopic plants and animals from the water.

Fact Sheet – Common Intertidal Plants

KELPS

Various—Kelps are large brown algaes that come in a variety of species. All kelps have a holdfast to attach the kelp to rocks, a stipe (similar to a stem), and a blade. The long and wavy large sugar kelp that grows to 10 feet in length, the odd sea colander that has a hole-riddled blade, and the horsetail kelp, that has long wavy fingers can all be found in the lower tidepools where the tide rarely leaves them exposed.

BLADDER WRACK

Fucus vesiculosus—Dominating the mid tidal range, bladder wrack is an olive brown algae with flattened blades up to two feet in length. Its name comes directly from the air bladders that are paired along the blades. Swollen receptacles at the end of the blades are for reproduction.

KNOTTED WRACK

Ascophylllum nodosum—Knotted wrack has narrow leather blades and is found in association with bladder wrack. Its tangled clumps create dense forests for intertidal animals to hide in. Like the bladder wrack it also has air bladders which help the seaweed to float during high tide. Both bladder wrack and knotted wrack make up the rockweed zone, one of the five distinct zones in tidepools.

IRISH MOSS

Chondrus crispus—A short and frilly red seaweed, Irish moss is found in the lower intertidal zone. Its color is obvious during low tide when brownish-red bands of Irish moss can be seen.